Array of Optical Signal Processing Devices

Moveable Reflector

'714 Claims 18 and 19: "Array of Optical Signal Processing Devices"

18. A light processing system, comprising:

. . . an **array of optical signal processing devices** located on one or more semiconductor substrates

. . . at least some of the **optical signal processing devices** comprise:

. . . a plurality of at least partially reflective mirrors . . .

'714 Claims 18 and 19: "Array of Optical Signal Processing Devices"

19. A method of processing one or more optical signals, the method comprising:

. . . receiving at least the first portion of the first signal part at an array of optical signal processing devices, the array of optical signal processing devices located on one or more semiconductor substrates and comprising a plurality of at least partially reflective mirrors . . .

'714 Patent, Claims 18 and 19: "Array of Optical Signal Processing Devices"

Cheetah's Construction	Defendants' Construction
A plurality of mirrors arranged in a regular pattern that process the optical signal	Array of variable blazed gratings

'714 Claims 18 and 19: "Moveable Reflector"

18. A light processing system, comprising:

. . . a moveable reflector operable to receive at least some of the portion of the first signal part from the array of optical signal processing devices . . .

'714 Claims 18 and 19: "Moveable Reflector"

19. A method of processing one or more optical signals, the method comprising:

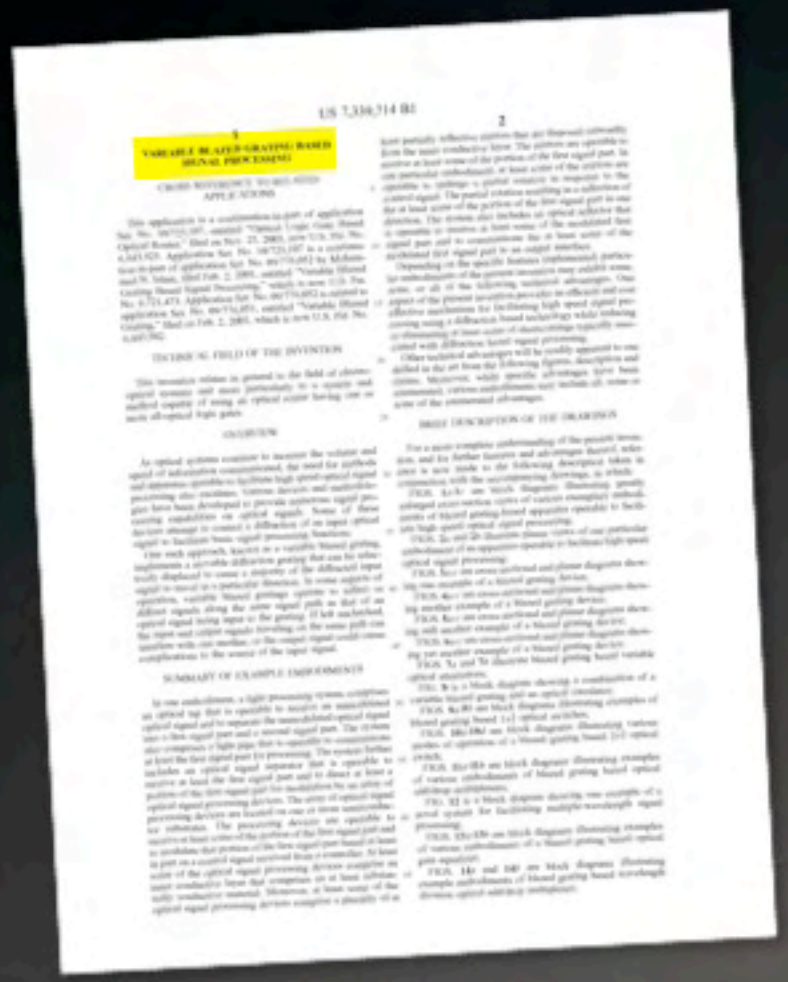
. . . receiving at a moveable reflector at least some of the first portion of the first signal part from the array of optical signal processing devices . . .

'714 Claims 18 and 19: "Moveable Reflector"

Cheetah's Construction	Defendants' Construction
A mirror that moves as a result of an applied voltage	A variable blazed grating

The '714 Patent's Title Proves the Purported Invention Requires the Use of Variable Blazed Gratings

The title states the scope of the purported invention



US 7,330,714 B1

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VARIABLE BLAZED GRATING BASED SIGNAL PROCESSING

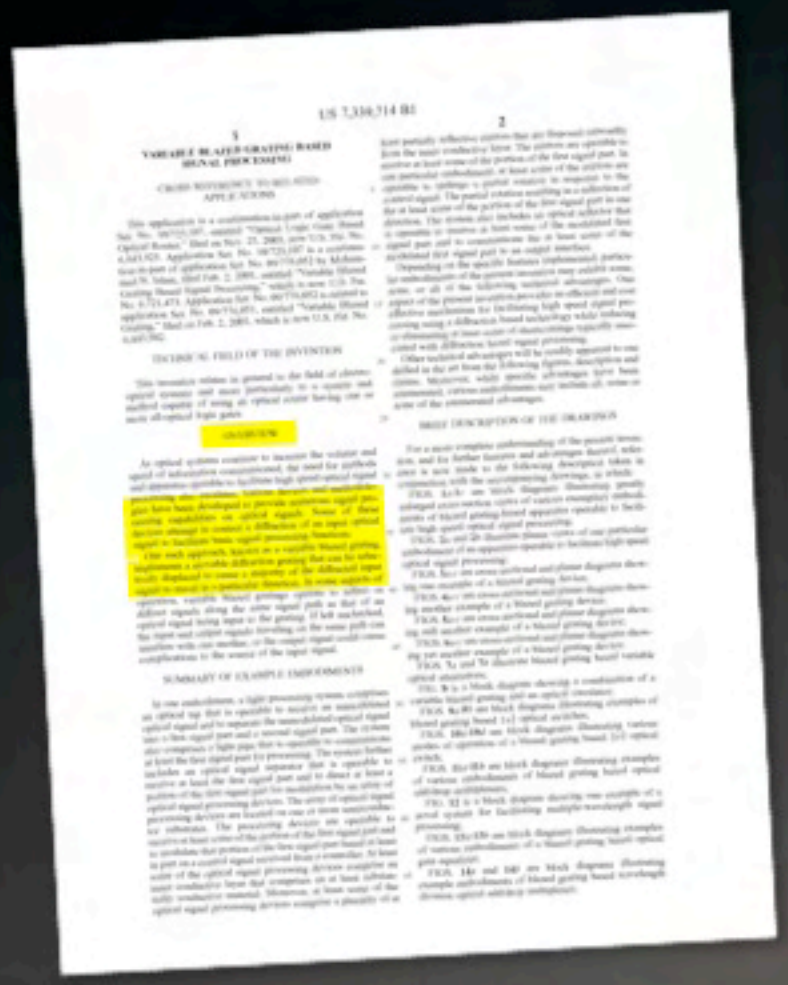
2

'714 Patent, col. 1 ll. 31-39.

VARIABLE BLAZED GRATING BASED SIGNAL PROCESSING

MPEP Section 606.01 ("Where the title is not descriptive of the invention claimed, the examiner should require the substitution of a new title that is clearly indicative of the invention to which the claims are directed.").

The '714 Patent's Overview Confirms the Purported Invention Requires the Use of Variable Blazed Gratings



OVERVIEW

processing also escalates. Various devices and methodologies have been developed to provide numerous signal processing capabilities on optical signals. Some of these devices attempt to control a diffraction of an input optical signal to facilitate basic signal processing functions.

One such approach, known as a variable blazed grating, implements a movable diffraction grating that can be selectively displaced to cause a majority of the diffracted input signal to travel in a particular direction. In some aspects of

'714 Patent, col. 1 ll. 31-39.

Every Embodiment of the '714 Uses Variable Blazed Gratings

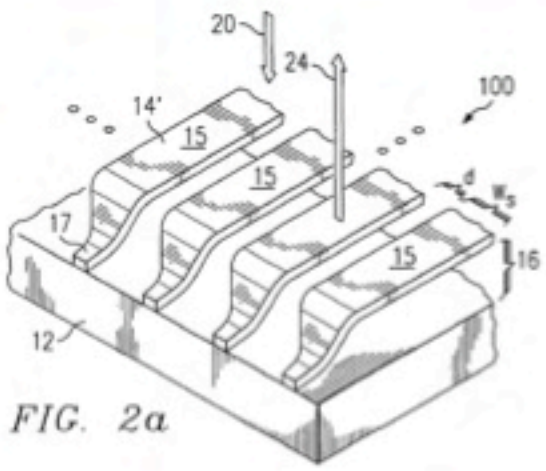


FIG. 2a

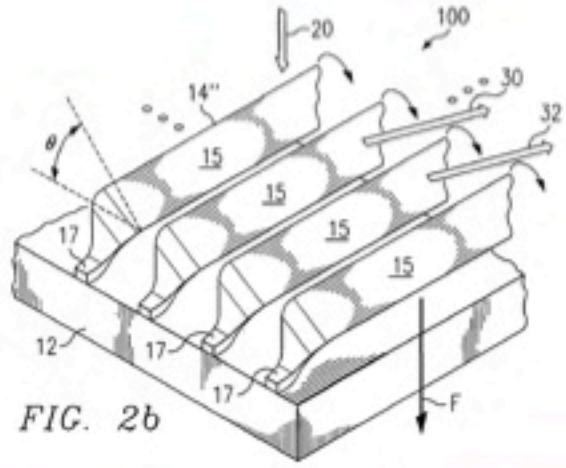


FIG. 2b

13a: Optical Gain Equalizer

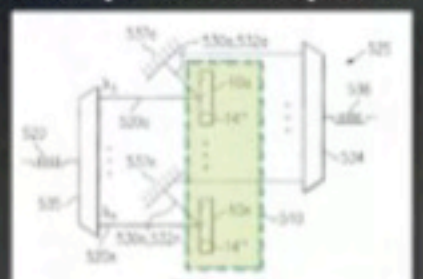


FIG. 13a

13b: Optical Gain Equalizer

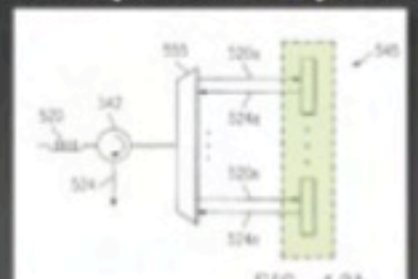


FIG. 13b

7a: Optical Attenuator

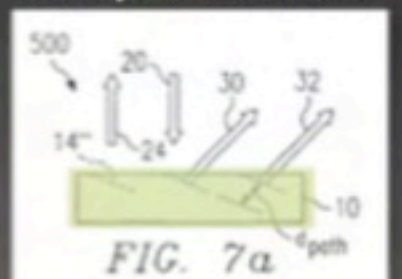


FIG. 7a

7b: Optical Attenuator

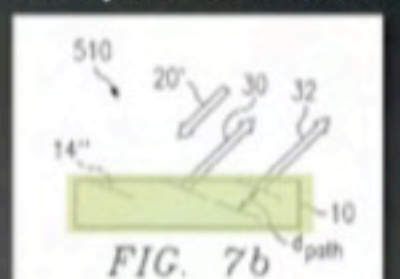


FIG. 7b

9a: Optical Switch

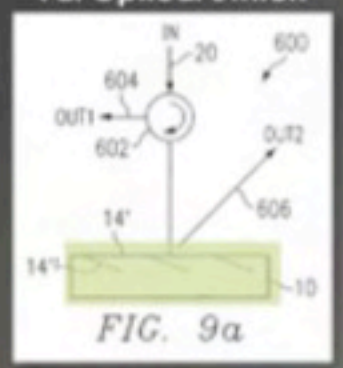


FIG. 9a

9b: Optical Switch

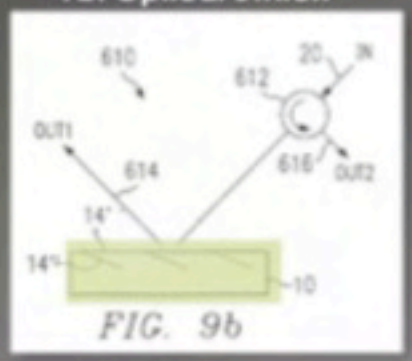


FIG. 9b

15: Electro-Optic Switch

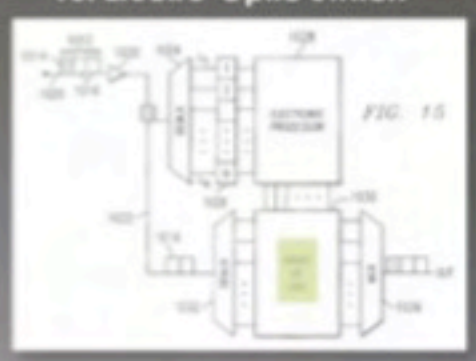


FIG. 15

14a: Add/drop Multiplexer

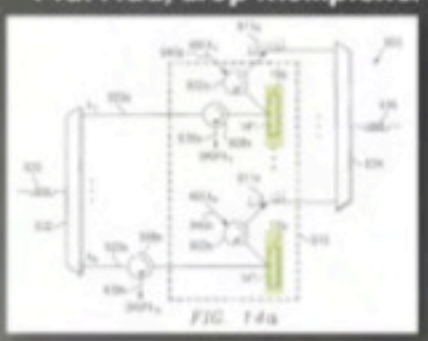
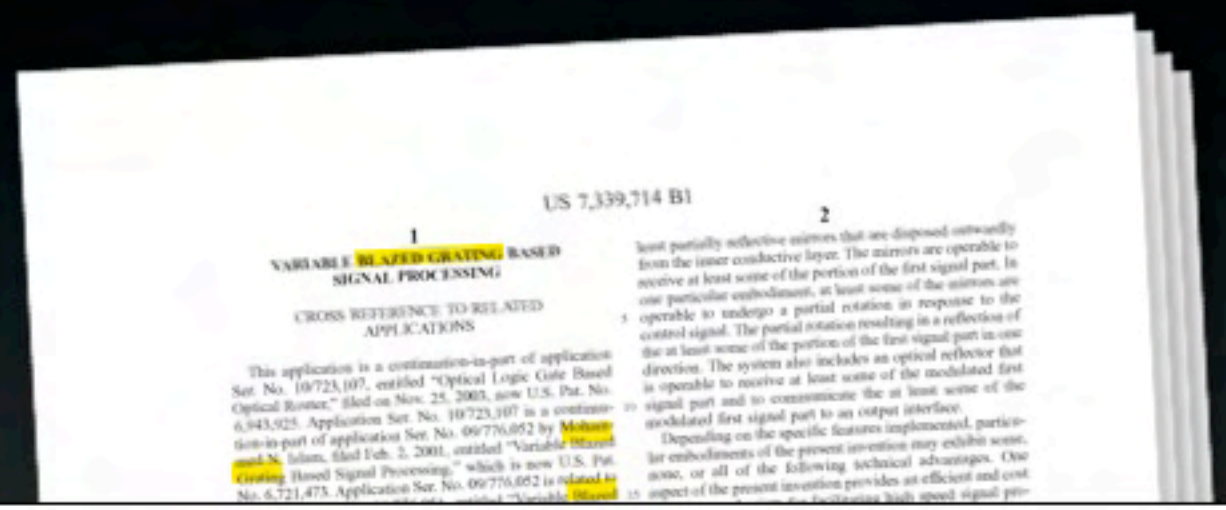


FIG. 14a

Variable Blazed Gratings are Referred to 145 Times in the '714 Patent



US 7,339,714 B1

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VARIABLE BLAZED GRATING BASED SIGNAL PROCESSING

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part of application Ser. No. 10/723,107, entitled "Optical Logic Gate Based Optical Router," filed on Nov. 25, 2003, now U.S. Pat. No. 6,943,925. Application Ser. No. 10/723,107 is a continuation-in-part of application Ser. No. 09/776,052 by Mohamed and N. Islam, filed Feb. 2, 2001, entitled "Variable Blazed Grating Based Signal Processing," which is now U.S. Pat. No. 6,721,473. Application Ser. No. 09/776,052 is related to

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least partially reflective mirrors that are disposed outwardly from the inner conductive layer. The mirrors are operable to receive at least some of the portion of the first signal part. In one particular embodiment, at least some of the mirrors are operable to undergo a partial rotation in response to the control signal. The partial rotation resulting in a reflection of the at least some of the portion of the first signal part in one direction. The system also includes an optical reflector that is operable to receive at least some of the modulated first signal part and to communicate the at least some of the modulated first signal part to an output interface.

Depending on the specific features implemented, particular embodiments of the present invention may exhibit some, none, or all of the following technical advantages. One aspect of the present invention provides an efficient and cost

blazed grating

...But Cheetah Argues that the Claims Do Not Require Variable Blazed Gratings

as "a plurality of at least partially reflective mirrors." Nothing in the asserted claims requires that the array comprise "variable blazed gratings." Defendants improperly import that detail from a preferred embodiment described in the '714 specification.

Cheetah's Claim Construction Br. at 9.

...But Cheetah Argues that the Claims Do Not Require Variable Blazed Gratings

Cheetah misreads its specification

FIG. **1***a* shows a cross-section view of one exemplary embodiment of a variable blazed grating-based apparatus **100** operable to facilitate high speed optical signal processing. Throughout this document, the term "signal processing" includes attenuation, switching, phase shifting, or any other manipulation of one or more optical signals.

In this example, apparatus **100** includes a substrate **12** and a plurality of strips **14** disposed outwardly from substrate **12**. In a particular embodiment, substrate **12** comprises a semiconductor substrate formed, for example, from silicon. Other materials could be used for substrate **12** without departing from the scope of the invention.

Each strip **14** has a width (W_s), and is separated from adjacent strips by a distance (d). The width (W_s) and the distance (d) define a periodicity associated with the strips. Multiple strips **14** are operable to receive a single input optical signal **20** having a beam width (W_b). Strips **14** are sized and spaced from one another in a manner to ensure that the width (W_b) of received optical beam **20** covers at least two strips **14**. In this example, strips **14** residing at position **14'** are spaced from substrate **12** by a distance **16**. Although strips **14** are shown as generally rectangular in shape, any shape can be used consistent with the invention. In addition, although strips **14** are shown as having a constant width (W_s), that measurement could vary between strips, or even along the same strip **14**.

'714 Patent col. 3 ll. 17-42.

"The '714 specification specifically states that optical devices other than variable blazed gratings may be used"

Cheetah's Reply at 9.

...But Cheetah Argues that the Claims Do Not Require Variable Blazed Gratings

Cheetah misreads its specification

FIG. **1***a* shows a cross-section view of one exemplary embodiment of a variable blazed grating-based apparatus **100** operable to facilitate high speed optical signal processing. Throughout this document, the term "signal processing" includes attenuation, switching, phase shifting, or any other manipulation of one or more optical signals.

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'714 Patent col. 3 ll. 17-42.

The paragraph is referring to a variable blazed grating

"The '714 specification specifically states that optical devices other than variable blazed gratings may be used"

Cheetah's Reply at 9.

Cheetah Can Identify No Support for Devices Other than Variable Blazed Gratings

"Support" Identified by Cheetah

These examples show two particular configurations for using a blazed grating as a 2×2 optical switch. It should be noted that any number of 2×2 optical switches can be combined to form an array of n×n switches. Moreover, although particular configuration has been described with respect to FIGS. **10***a*-**10***d*, numerous modifications could be made without departing from the scope of the invention. For example, switches implementing different geometric configurations, or different numbers of blazed grating elements, circulators, reflective surfaces, or other optical elements are contemplated as being within the scope of the invention.

'714 Patent, col. 14 ll. 55-65.

"The '714 specification specifically states that optical devices other than variable blazed gratings may be used"

Cheetah's Reply at 9.

Cheetah Can Identify No Support for Devices Other than Variable Blazed Gratings

"Support" Identified by Cheetah

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'714 Patent, col. 14 ll. 55-65.

blazed gratings

"The '714 specification specifically states that optical devices other than variable blazed gratings may be used"

Cheetah's Reply at 9.

The Boilerplate Identified by Cheetah Does Not Discuss Any Signal Processing Device Other than a Blazed Grating

These examples show two particular configurations for using a blazed grating as a 2×2 optical switch. It should be noted that any number of 2×2 optical switches can be combined to form an array of n×n switches. Moreover, although particular configuration has been described with respect to FIGS. **10***a*-**10***d*, numerous modifications could be made without departing from the scope of the invention. For example, switches implementing different geometric configurations, or different numbers of blazed grating elements, circulators, reflective surfaces, or other optical elements are contemplated as being within the scope of the invention.

'714 Patent, col. 14 ll. 55-65.

- Does not teach the use of any other MEMS device
- Does not state that a system could be built with no blazed grating

The '714 Patent Shows the Use of Variable Blazed Gratings in Which Only Some of the Mirror Strips Rotate

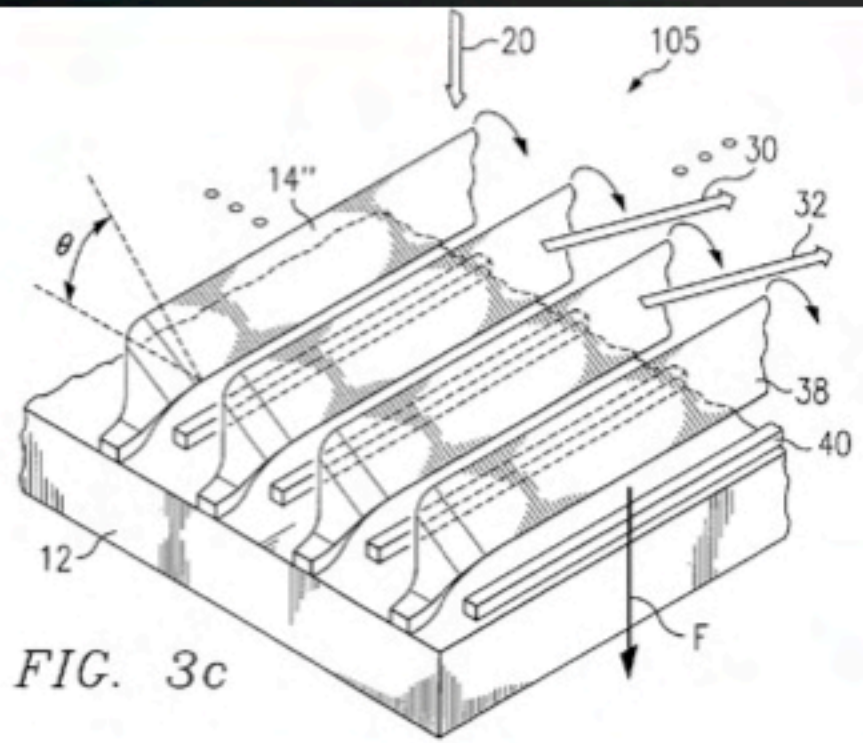

FIG. 3c

In the illustrated example, a common voltage (or ground) is applied to all strips **14**. Alternatively, selected strips **14** could be rotated while others remain stationary.

'714 Patent, col. 7 ll. 39-42.

"Moveable Reflector" Is Not Found in the Written Description

- The patent discusses "variable blazed gratings" in detail

- The term "moveable reflector" does not appear a single time prior to the claims

The Boilerplate Identified by Cheetah Does Not Describe "Moveable Reflector"

These examples show two particular configurations for using a blazed grating as a 2×2 optical switch. It should be noted that any number of 2×2 optical switches can be combined to form an array of n×n switches. Moreover, although particular configuration has been described with respect to FIGS. **10***a*-**10***d*, numerous modifications could be made without departing from the scope of the invention. For example, switches implementing different geometric configurations, or different numbers of blazed grating elements, circulators, reflective surfaces, or other optical elements are contemplated as being within the scope of the invention.

'714 Patent, col. 14 ll. 55-65.

- Does not support a reflective surface that moves (other than a variable blazed grating)
- "Reflective surface" does not suggest a moving reflective surface
- "Optical elements" does not describe a moveable reflector
- Does not support the combination of elements found in claims 18 and 19
- Does not suggest going without a blazed grating

Claims 18 and 19

18. A light processing system, comprising:
an optical divider operable to receive an unmodulated optical signal and to separate the unmodulated optical signal into a first signal part and a second signal part;
a light pipe operable to communicate at least the first signal part for processing;
an optical signal separator operable to receive at least the first signal part and to direct at least a portion of the first signal part for modulation;
an array of optical signal processing devices located on one or more semiconductor substrates, the array of optical signal processing devices operable to receive at least some of the portion of the first signal part and to modulate that portion of the first signal part based at least in part on a control signal received from a controller, at least some of the optical signal processing devices comprise:
an inner conductive layer comprising an at least substantially conductive material; and
a plurality of at least partially reflective mirrors disposed outwardly from the inner conductive layer and operable to receive at least some of the portion of the first signal part, wherein at least some of the mirrors are operable to undergo a partial rotation in response to the control signal, the partial rotation resulting in a reflection of the at least some of the portion of the first signal part, and wherein a majority of the reflected signal is communicated in one direction; and

a moveable reflector operable to receive at least some of the portion of the first signal part from the array of optical signal processing devices and to reflect that portion of the first signal part to an optical reflector, the optical reflector operable to receive at least some of the modulated first signal part and to communicate the at least some of the modulated first signal part to an output interface.

Claim 18 and 19 require **both**
"an array of optical signal processing devices [comprising] a plurality of at least partially reflective mirrors"

AND

"a moveable reflector"

Only One Embodiment Teaches the Use of Both Rotating Mirrors AND a Moving Reflecting Device

The devices are **both** variable blazed gratings

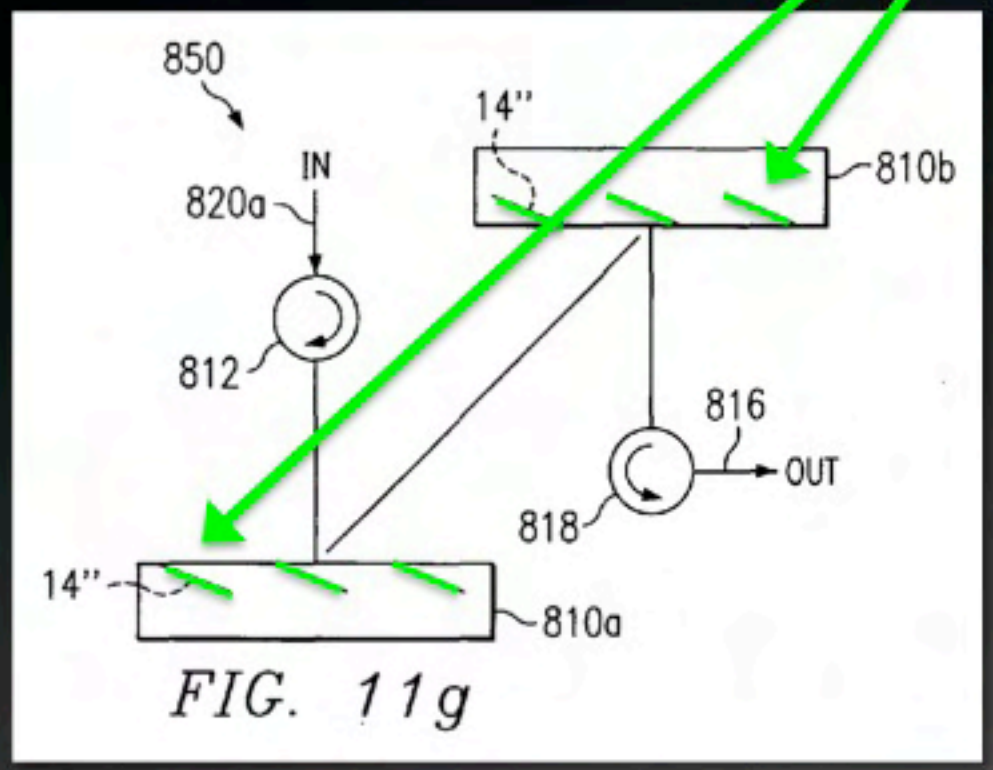

FIG. 11g

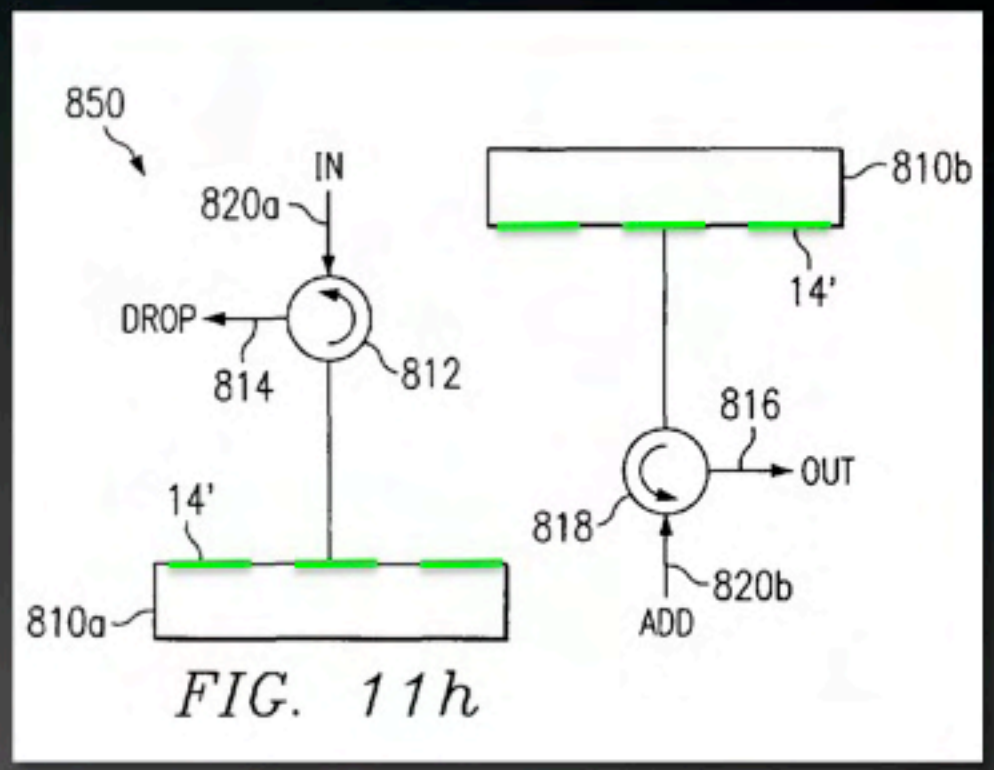

FIG. 11h

FIGS. **11***g* and **11***h* are block diagrams showing still another embodiment of an optical add/drop multiplexer **850** implementing blazed grating technology. In this example, add/drop multiplexer **850** includes two blazed grating elements **810***a* and **810***b*, each communicating with one of circulators **812** and **818**. Circulator **812** receives input signal **820***a* and is coupled to a drop port **814**, while circulator **818** receives added signal **820***b* and is coupled to output port **816**.

'714 Patent, col. 16 ll. 43-51.

A Variable Blazed Grating Can Act as a Single "Reflector"

- Contrary to Cheetah's argument, the patent speaks of **multiple** mirror strips in a variable blazed grating "reflecting" a **single** input beam

In this embodiment, apparatus **100** operates in reflection mode when strips **14** reside at positions **14'**. In that mode, input beam **20** impinges on strips **14** at angle PHI and is reflected as shown by output beam portion **24** at an angle of 180 degrees minus PHI. In diffraction mode, strips **14** reside at positions **14"** at an angle THETA from position **14'**. In this case, grazing angle PHI is selected to result in a diffraction angle that is approximately equal to the incident angle (ninety degrees minus PHI), resulting in input beam **20** being diffracted back in approximately the same direction as the origin of input beam **20**, as shown by output rays **30** and **32**.

'714 Patent, col. 5 ll. 3-14.

Reflection

'714 Claim 18: The Reflection Limitation

18. A light processing system, comprising:

. . . a plurality of at least partially reflective mirrors

. . . wherein at least some of the mirrors are operable to undergo a partial rotation in response to the control signal, the partial rotation resulting in a reflection of the at least some of the portion of the first signal part

'714 Claim 19: The Reflection Limitation

19. A method of processing one or more optical signals, the method comprising:

. . . rotating at least some of the mirrors in response to one or more control signals, the rotation of the at least some of the mirrors resulting in a reflection of the at least some of the portion of the optical signal.

'714 Claims 18 and 19: The Reflection Limitation

Cheetah's Construction	Defendants' Construction
Rotating the mirrors to reflect at least some portion of the first signal part (claim 18) / optical signal (claim 19)	These limitations require that the "array of optical signal processing devices" operate in the disclosed "reflection mode," i.e. redirecting light from a mirror that is parallel to the inner conductive layer.

The '714 Patent Distinguishes Between Reflection Mode and Diffraction Mode

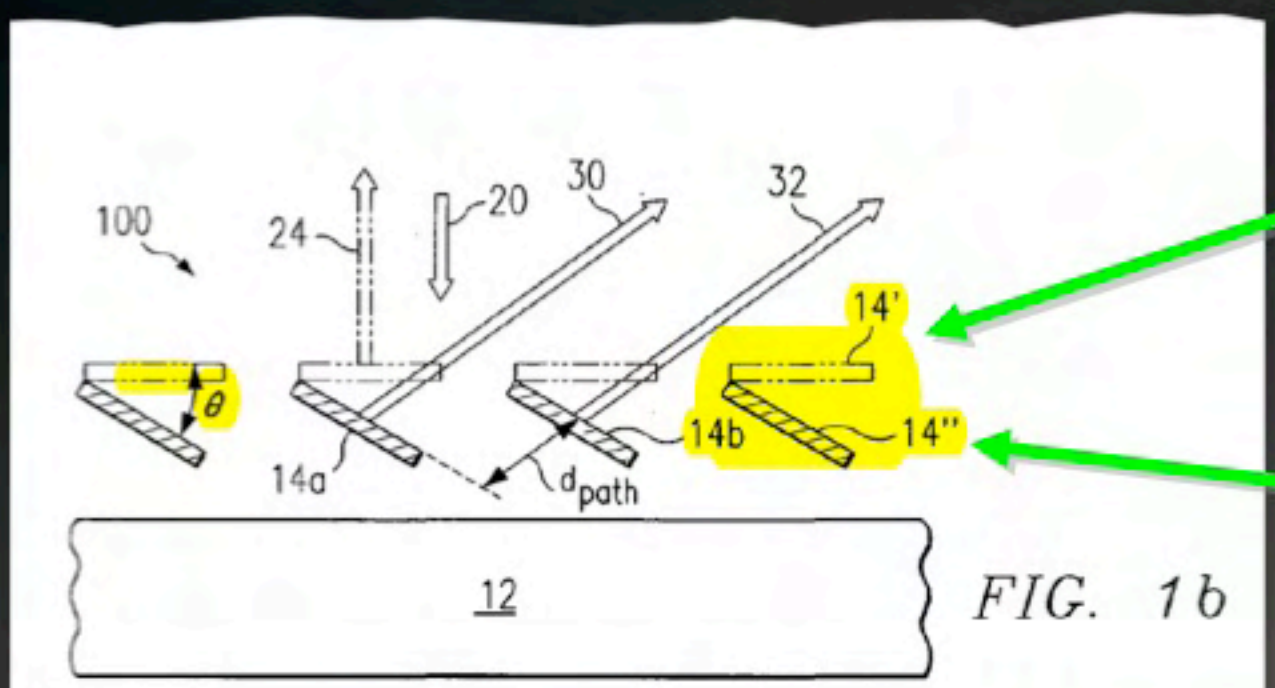

FIG. 1b

"reflection mode,"

Strips **14** at position **14'** (shown in dotted lines) show apparatus **100** operating in "reflection mode," where strips **14** operate to reflect input optical beam **20** as reflected signal **24**. In this case, because input beam **20** is oriented normally to the surfaces of strips **14**, reflected beam **24** is communicated back in the same direction from which input beam **20** originated. As will be discussed below, non-normal input angles could also be used.

Strips at positions **14"** (shown in solid lines) depict strips **14** during a second mode of operation, "diffraction mode." In diffraction mode, strips **14** are each rotated by approximately a blaze angle THETA from the original position of strips **14**. In a particular embodiment, strips **14** can obtain a

"diffraction mode."

'714 Patent, col. 4 ll. 11-24.

In "Reflection Mode," the Mirrors are Parallel to the Inner Conductive Layer

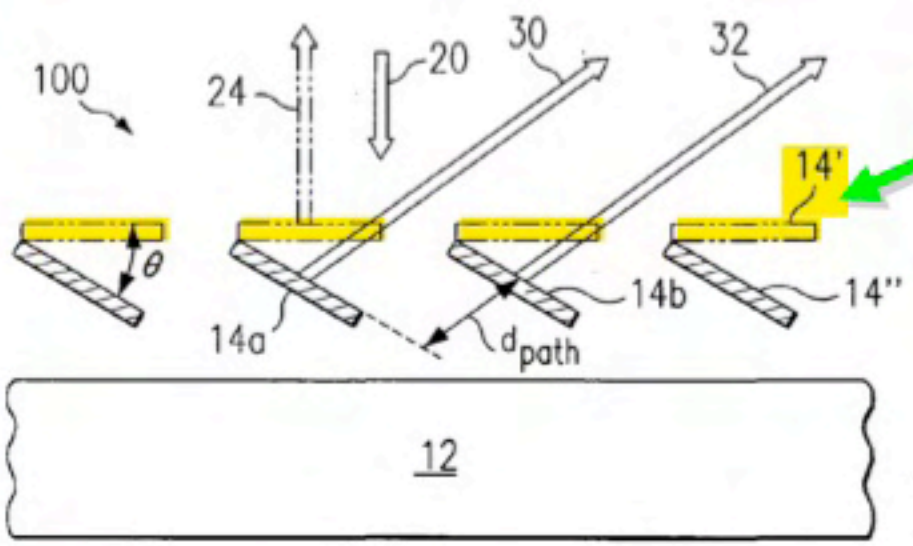

FIG. 1b

Strips **14** at position **14'** (shown in dotted lines) show apparatus **100** operating in "reflection mode," where strips **14** operate to reflect input optical beam **20** as reflected signal **24**. In this case, because input beam **20** is oriented normally

'714 Patent, col. 4 ll. 11-14.

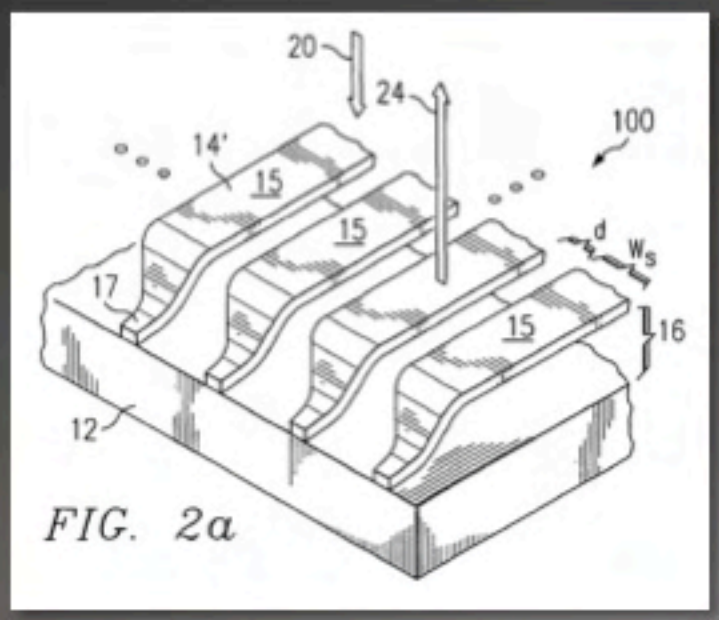

FIG. 2a

In "Diffraction Mode," the Mirrors are Angled to the Inner Conductive Layer

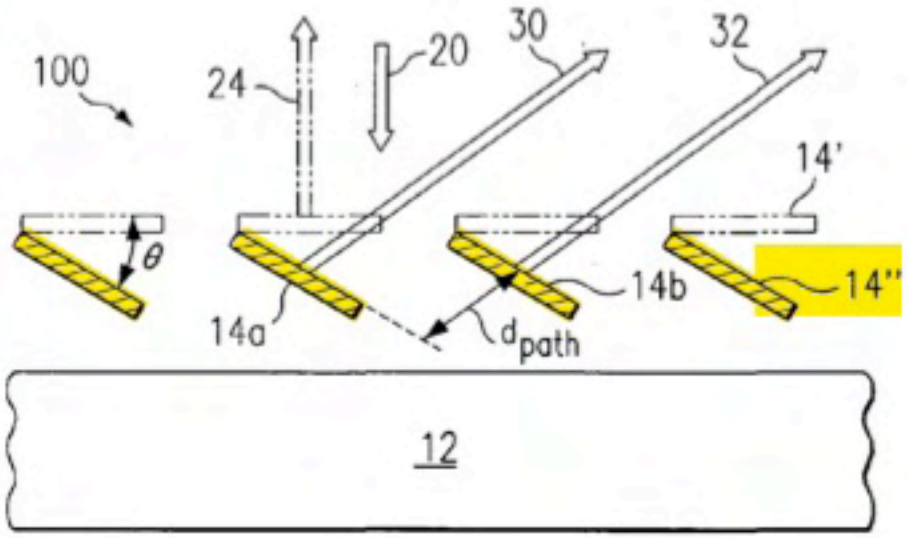

FIG. 1b

Strips at positions **14"** (shown in solid lines) depict strips **14** during a second mode of operation, "diffraction mode." In diffraction mode, strips **14** are each rotated by approximately a blaze angle THETA from the original position of strips **14**.

'714 Patent, col. 4 ll. 20-24

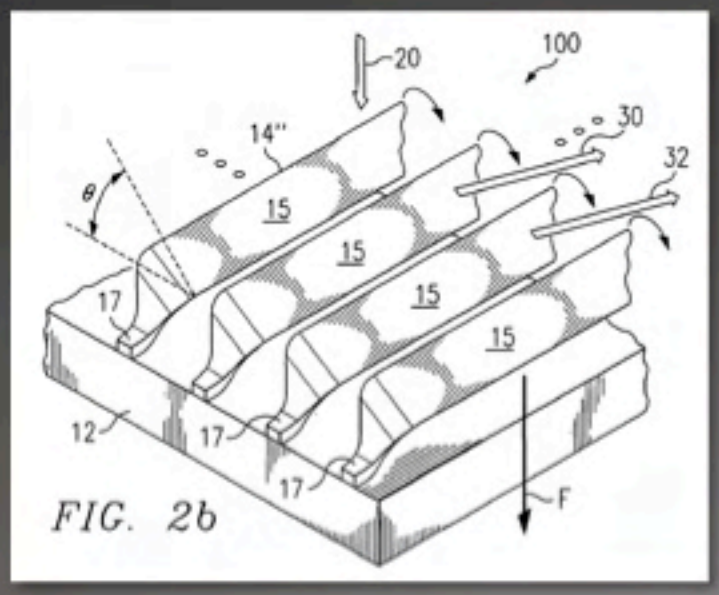

FIG. 2b

In the '714 Patent, "Reflect" and "Diffract" Mean Different Things

In some aspects of operation, variable blazed gratings operate to reflect or diffract signals along the same signal path as that of an optical signal being input to the grating.

'714 Patent, col. 1 ll. 39-42.

In some aspects of operation, variable blazed gratings operate to reflect or diffract signals along the signal path of the same or another input signal.

'714 Patent, col. 12 ll. 56-58.

Where variable blazed grating **10** operates to reflect or diffract signals back in the direction of any input signal to the system, circulators could be used to redirect the reflected or diffracted signals to enhance system performance.

'714 Patent, col. 20 ll. 1-5.

Where variable blazed grating **10** operates to reflect or diffract signals back in the direction of any input signal to the system, circulators could be used to redirect the reflected or diffracted signals to enhance system performance.

'714 Patent, col. 22 ll. 27-30.

"Reflect" Refers to the Reflection Mode (Parallel Mirrors) and "Diffract" Refers to the Diffraction Mode (Angled Mirors)

In reflection mode (as indicated in FIG. **4***a* by dashed lines) apparatus **110** substantially reflects input optical beam **20** back in the same direction as output beam **24**. In diffraction mode, apparatus **110** diffracts input optical beam **20** primarily in a direction as indicated by output rays **30** and **32**.

'714 Patent, col. 8 ll. 34-39.

In a reflection mode of operation, blazed grating apparatus **115** receives optical input beam **20**, and reflects beam **20** at an angle equal to the angle of incidence of beam **20**.

'714 Patent, col. 9 ll. 47-49.

In diffraction mode, blazed grating **10** is displaced to position **14"** at an angle THETA from position **14'**. Blazed grating **10** receives optical input beam **20***a* and diffracts a majority of that beam toward circulator **708**, which directs that portion of the beam to output **706**.

'714 Patent, col. 14 ll. 23-27.

Claims in the '714 Patent Family Distinguish Between Reflection and Diffraction Too

United States Patent
Islam et al.

(10) **Patent No.: US 6,721,473 B1**
(45) **Date of Patent: Apr. 13, 2004**

43. An optical switching element comprising:

a plurality of approximately adjacent at least partially reflective mirror strips disposed outwardly from the inner conductive layer, each strip operable to receive a portion of an input optical signal wherein each of the plurality of strips is operable to undergo a partial rotation resulting in a reflection of a majority of the input signal toward an output; and

51. An optical switching element, comprising:

a variable blazed grating operable to receive a first optical input signal from a first input and to reflect the first signal toward a first output while the grating remains in a first position, the variable blazed grating further operable to undergo a displacement to a second position, the displacement resulting in a diffraction of a majority of the first input signal toward a second output;

The '714 patent claims priority to U.S. Patent No. 6,721,473, its grandparent.

Cheetah Erroneously Argues that a Mirror Cannot "Rotate" to a Parallel Position

PLAINTIFF CHEETAH OMNI'S P.R. 4-5(c)
REPLY BRIEF ON CLAIM CONSTRUCTION

(omitted in Defendants' Brief) readily resolves the debate. The claim expressly states that a "rotation" of the mirrors results in the "reflection." Obviously, the mirrors are not "parallel" to the inner conductive layer when they are "rotated."

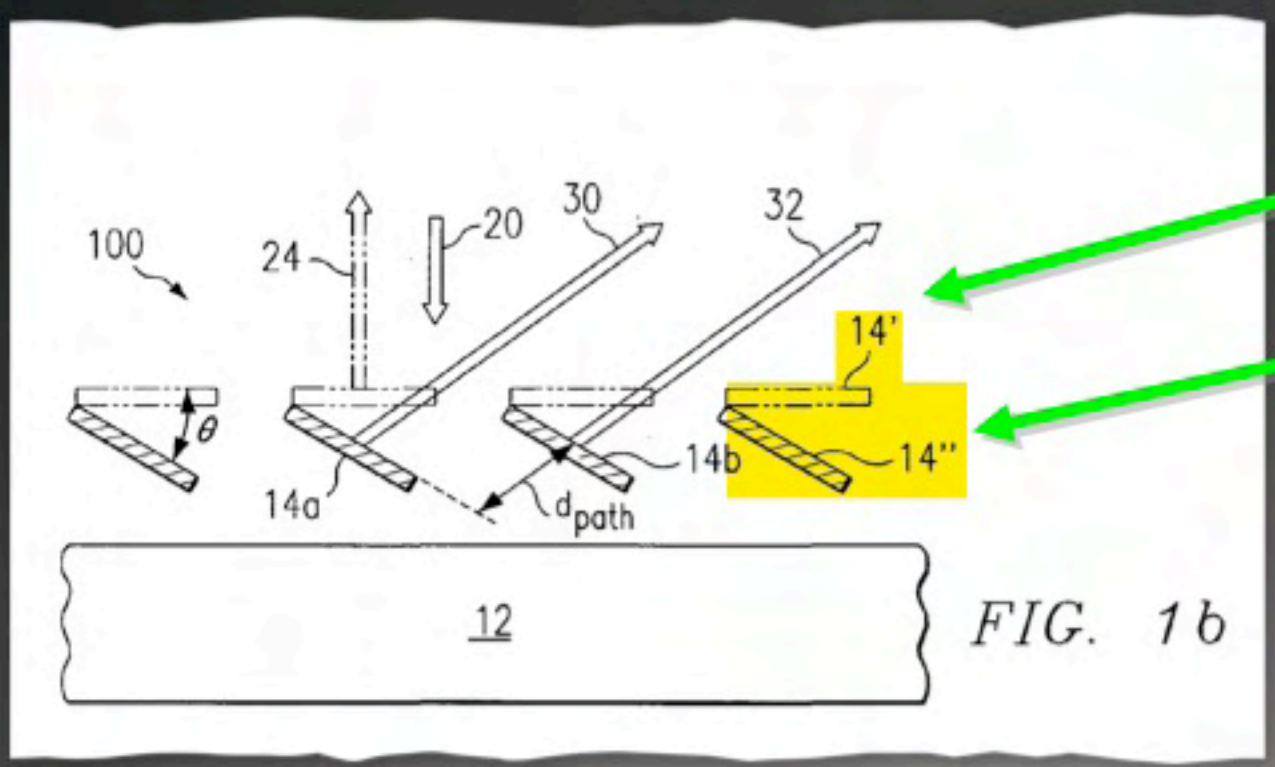

FIG. 1b

But the mirrors can rotate

to a parallel position (14')

from the tilted position (14")